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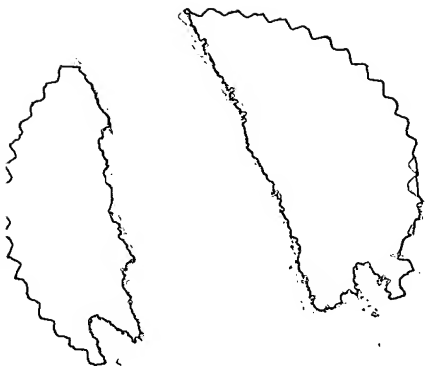
THE PATENTS ACT, 1970

IT IS HEREBY CERTIFIED THAT, the annex is a true copy of Application and Provisional specification filed on 14.8.2001 in respect of Patent Application No. 796/Mum/2001 of Tata Consultancy Services (a Division of Tata Sons Limited) of Bombay House, Sir Homi Mody Street, Mumbai 400 023, Maharashtra, India an Indian Company.

This certificate is issued under the powers vested on me under Section 147(1) of the Patents Act, 1970.....



.....Dated this 25th day of January 2002.

(N.K.Garg)

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FORM-1

THE PATENTS ACT, 1970

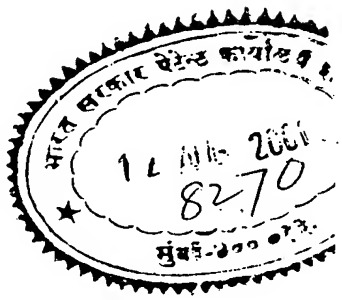
(39 OF 1970)

APPLICATION FOR GRANT OF A PATENT

(See sections 5(2), 7, 54 and 135 and rule 33A)

Cash/PF
14/8/01

1. I/We, TATA CONSULTANCY SERVICES (a Division of TATA SONS LIMITED), of Bombay House, Sir Homi Mody Street, Mumbai 400 023, Maharashtra, India, an Indian Company,



2. hereby declare :-

(a) that I am/we are in possession is an invention titled METHOD AND APPARATUS FOR IMPROVED USE OF LEGACY SYSTEMS

ORIGINAL 796 | मुंबई MUM | 2001

(b) that the Provisional/Complete specification relating to this invention is filed with this application

14 AUG 2001

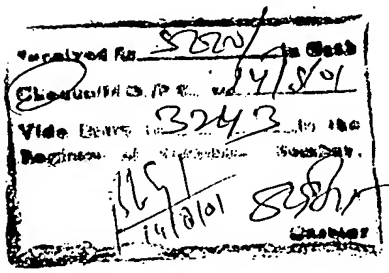
(c) that there is no lawful ground of objection to the grant of a patent to me/us.

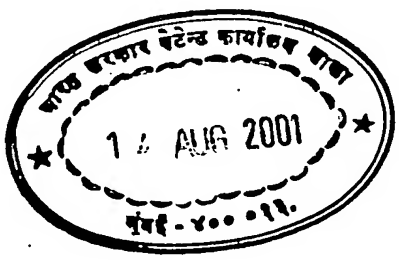
3. further declare that the inventor(s) for the said invention is/are :

796/mum/2001
14/8/2001

(a) VINAY VASANT KULKARNI of Tata Consultancy Services, Hadapsar Industrial Estate, Pune 411 013, Maharashtra, India, an Indian National; and

(b) SREEDHAR SANNAREDDY REDDY of Tata Consultancy Services, Hadapsar Industrial Estate, Pune 411 013, Maharashtra, India, an Indian National





4. I/We, claim the priority from the application(s) filed in convention countries, particulars of which are as follows :

(a) [Country]

(b) [Appln.No.] N.A.

(c) [Date of Appln.]

(d) [Applicant in Convention Country]

(e) [Title]

5. I/We state that the said invention is an improvement in or modification of the invention, the particulars of which are as follows and of which I/We are the applicant/patentee :

(a) Application No.

(b) Date of application N.A.

6. I/We state that the application is divided out of my/our application, the particulars of which are given below and pray that this application deemed to have been filed on date under section 16 of the Act.

(a) Application No.

N.A.

(b) Date of filing of provisional specification :

and date of filing of complete specification :

7. That XXXXWe are the assignee or legal representative of the true and first inventors.

8. That XXy/our address for service in India is as follows : **R.K. DEWAN & COMPANY,** Trade Marks & Patents Attorneys, 78, Podar Chambers, S.A.Brelvi Road, Fort, Mumbai 400 001, Maharashtra, India, Tel. (91) 22-2661662/2663002, Telefascimile number (91) 22-2650159, Email>rkdewan@vsnl.com.

9. Following declaration was given by the inventor(s) ~~or applicant(s) in the convention country~~:

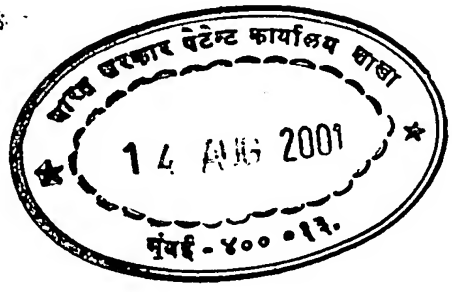
I/We the true and first inventors for this invention ~~of the applicant(s) in the convention country~~ declare that the applicant(s) herein is/are my/our assignee or legal representative :

Vinay

(VINAY VASANT KULKARNI)

(SREEDHAR SANNAREDDY REDDY)

10. That to the best of my/our knowledge, information and belief the fact and matters stated herein are correct and that there is no lawful ground of objection to the grant of patent to me/us on this application



11. Following are the attachment with the application :

(a) Provisional/Complete specification (3 copies)

(b) Drawings (3 Copies)

(c) [illegible]

(d) [illegible]

(e) Copy of General Power of authority

(f)

(g)

(h)

(i) Fee Rs. 5000/- In cash/cheque/bank draft bearing No.

date on Bank

I/We request that a patent may be granted to me/us for the said invention.

Dated this 14th day of August 2001

Signature : dwvakil

Name : (HEMANT DHANSUKHLAL VAKIL)

To :

The Controller of Patents

The Patent Office

at MUMBAI

FORM-2

THE PATENT ACT, 1970

PROVISIONAL

Specification

SECTION – 10

METHOD AND APPARATUS FOR IMPROVED USE OF LEGACY SYSTEMS

TATA CONSULTANCY SERVICES,
(a Division of TATA SONS LIMITED),
of Bombay House, Sir Homi Mody Street,
Mumbai 400 023, Maharashtra, India,
an Indian Company

THE FOLLOWING SPECIFICATION DESCRIBES THE NATURE OF THIS INVENTION :-

This invention relates to method and apparatus for improved use of legacy systems

Many mission critical systems are legacy systems. The use of legacy systems lead to the following problems:

- Legacy systems are difficult to maintain and enhance
- Legacy systems can be implemented using different, not necessarily compatible, programming paradigms and implementation platforms
- Legacy systems are not open enough to be integrated with other systems

These problems associated with the use of legacy systems severely hamper an organization's ability to respond to a business driven change or opportunity in a fast and flexible manner.

Organizations require an integrated view of their information systems and data owned by them. Therefore, it is important for such organizations to re-engineer legacy systems used by them into a more usable open architecture. However, legacy systems are typically very complex with little or no documentation and support infrastructure thus rendering the option of a complete rewrite non-viable.

Owing to the critical nature of legacy systems, a proposed approach a method and apparatus for using legacy systems must

- Minimize risk
- Optimize on return of investment
- Automate the re-engineering endeavor to the extent possible

In the prior art, the most common way of rejuvenating legacy systems is by wrapping them in an object façade and using some middleware (CORBA, SOM etc.) for connectivity. However, there is no comprehensive approach suggested in literature that addresses the following,

- Generic (middleware independent) connector framework
- Integration with a component development framework
- Data reconciliation across legacy systems

This invention provides a method and apparatus for improving the use of legacy systems that addresses the above issues.

The principal features of the apparatus and method of this invention comprises providing

- An object oriented, open, distributed, platform-agnostic component architecture enabling co-existence of legacy systems with state of the art componentised distributed systems
- A method for wrapping legacy system as a component
- A method for developing new functionality or enhancing existing functionality with as much reuse of the legacy systems as possible
- A generic connectivity bus and a framework for its realization
- A data reconciliation bus and a framework for its realization
- Tool support to automate the above processes.

The invention will now be described with reference to the accompanying drawings, in which.

Figure 1 shows an object oriented, open, distributed, platform-agnostic component architecture enabling co-existence of legacy systems with state of the art components;

Figure 2 shows a model for a component façade wrapping a legacy system.

Figure 3 is a block diagram showing the use of the method and apparatus of this invention for data reconciliation;

Figure 4 shows by way of example the tool support for the method and apparatus of this invention; and

Figure 5 shows the basemost framework class in accordance with this invention.

Referring to the drawings, an object oriented, open, distributed, platform-agnostic component architecture enabling co-existence of legacy systems with state of the art components is shown in figure 1.

Object façade is a component wrapper for the legacy system that makes a legacy system behave as an object providing services to the external world. A service is an n-tuple <methodName, input parameters, and output parameters>. It may have transaction semantics that are managed within it. If transaction boundary spans across legacy systems then RDBMSs of the legacy systems involved must be XA compliant. Object façade has an Adapter for handling data transformation from legacy world to the open world and vice versa.

Connectivity bus is a logical entity providing the following functionality,

- Connectivity between heterogeneous systems in a transparent manner
- Data transfer over the network in m/c independent manner

- Manages data transformations
- Supports transactions spanning across legacy systems through use of appropriate middleware

A framework providing choice of OLTP monitor, network and messaging system, as well as a facility to customise its behaviour supports realisation of connectivity bus.

Existing functionality of a legacy system can be enhanced or entirely new functionality can be added through new components. Type system of Object façade and new component is the same. Many ways exist for implementing a new component that is well known to a person skilled in the art.

It is possible for two legacy systems to have data redundancy between them. In disconnected systems, integrity of data across systems is achieved by effecting the necessary changes onto other system. Typically, this activity is performed in batch mode.

Data reconciliation bus provides services for this purpose.
A model for a component façade wrapping a legacy system is shown in figure 2.

A process of wrapping a legacy system as a component comprises of the following steps:

1. Identify the functionality expected of the legacy system by the external world.

2. Specify the functionality identified in step 1 above as a set of services in the type system of the legacy system. A service clearly identifies its input and output parameters.
3. A legacy system maps onto a Component having interface operations corresponding to the services identified in step 2 above.
4. For each service identified in step 2 above, define an interface operation in the type system of the component architecture as an n-tuple <methodName, input parameters, and output parameters>. At this stage, object model of component façade corresponding to the legacy system is completely defined.
5. For each legacy service, define a map from legacy type system to the type system of component architecture.

A model based generative mechanism generates implementation of component façade and adapter for each service for a legacy system into a framework. This default behaviour can be overridden.

The method proposed in accordance with this invention has following characteristics:

Legacy systems are reengineered into pure server side components that are devoid of GUI.

A driver component that defines, minimally, a control flow over the services and, ideally, a business process realisation in terms of the services, provides the GUI for the reengineered application.

The proposed technique is based on the following assumptions:

It is possible to map the data organisation primitives of programming language of the legacy system to those of C / C++ / Java.
Middleware providing transactional support, if required, across heterogeneous platforms exists.

Connectivity bus is a logical entity providing the following functionality,

- Connectivity between heterogeneous systems in a transparent manner
- Data transfer over the network in m/c independent manner
- Manages data transformations
- Supports transactions spanning across legacy systems through use of appropriate middleware

A framework providing choice of OLTP monitor, network and messaging system, as well as a facility to customise its behaviour supports realisation of connectivity bus. The basemost framework class is shown in Figure 5 of the drawings

It is possible for two legacy systems to have data redundancy between them. In disconnected systems, integrity of data across systems is achieved by effecting the necessary changes onto other system. Typically, this activity is performed in batch mode.

Data reconciliation bus provides services for this purpose.

Unified normalized layer (UNL) is a complete (data) model of the application i.e. set of legacy systems as well as new components. UNL is devoid of any redundancies.

Data model of a legacy system is expressed as an ER model. A legacy ER model is defined as a *View* over UNL.

Data reconciliation has two aspects to it

1) Changes to the data owned by *this* legacy system need to be propagated to the legacy systems wherein *this* data is replicated
2) Changes to the data not owned by *this* legacy system need to be propagated from the legacy system owning the data

A legacy specific DRS addresses the above two aspects. An example of the use of the method and apparatus of this invention for data reconciliation is seen in Figure 3.

Referring to Figure 3 Consider legacy systems LS1 and LS2 having data models LDM1 and LDM2 respectively. LERM1 and LERM2 are the ER models corresponding to LDM1 and LDM2 respectively. Assume T1 and T2 are redundant tables between LS1 and LS2 such that LS1 and T2 own T1 by LS2. Therefore, updates of interest to T1 in LS1 need to be propagated to T1 in LS2 and, updates of interest to T2 in LS2 need to be propagated to T2 in LS1. User provides, for LS1, a function LS1_DRS_out for the former and LS1_DRS_in for the latter and similarly for LS2.

A model based generative approach provides for in-memory realization of UNL as well as a legacy ER model. This serves as a placeholder for side-effects of interest produced by user supplied function LS1_DRS_out that are input to another user supplied function LS2_DRS_in which propagates them to LS2 thus completing data reconciliation of LS2 with LS1.

The tool support, as shown in fig. 4, comprises the following:

1. An object modeling tool for defining object models of new components, services of legacy systems interface operations of component façade.
2. An ER modeling tool
3. A robust, multi-user repository for storing object models and their versioning and configuration management.
4. A higher level programming language for specifying mediator functionality.
5. A mechanism to model GUI of the reengineered application
6. A pre-defined set of types for expressing type system of legacy systems.
7. A mechanism to define an ER (object) model as a view over another ER (object) model
8. Complete generation of object façade from the model
9. Complete generation of new components from the model and specification language
10. Connectivity bus framework
11. Data reconciliation bus framework

The advantages of the method and apparatus of this invention include the following:

Open, object oriented, platform-agnostic, distributed and component architecture for the reengineered system

Complete generation of Object façade from the model

Higher level mechanism to specify control flow and mediator functionality and, complete generation from these specifications

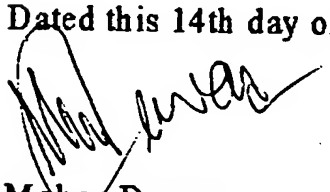
Unit testing harness and regression testing mechanism

Connectivity bus

Configurability with respect to implementation technology platforms such as presentation manager, RDBMS, programming language and middleware.

Although the invention has been described in terms of particular embodiments and applications, one of ordinary skill in the art, in light of this teaching, can generate additional embodiments and modifications without departing from the spirit of or exceeding the scope of the invention. Accordingly, it is to be understood that the drawings and descriptions herein are proffered by way of example to facilitate comprehension of the invention and should not be construed to limit the scope thereof.

Dated this 14th day of August 2001



Mohan Dewan
Of R K Dewan & Co
Applicants' Patent Attorney

NAME : TATA CONSULTANCY SERVICES
(TATA SONS LIMITED)

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SHEET NO. : 1

NO. : / MUM / 01

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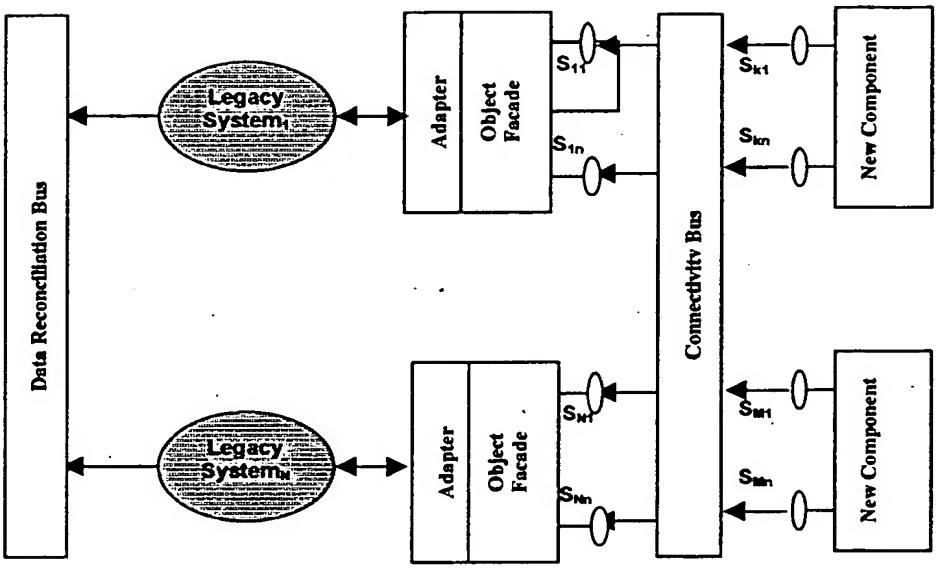

Fig 1.

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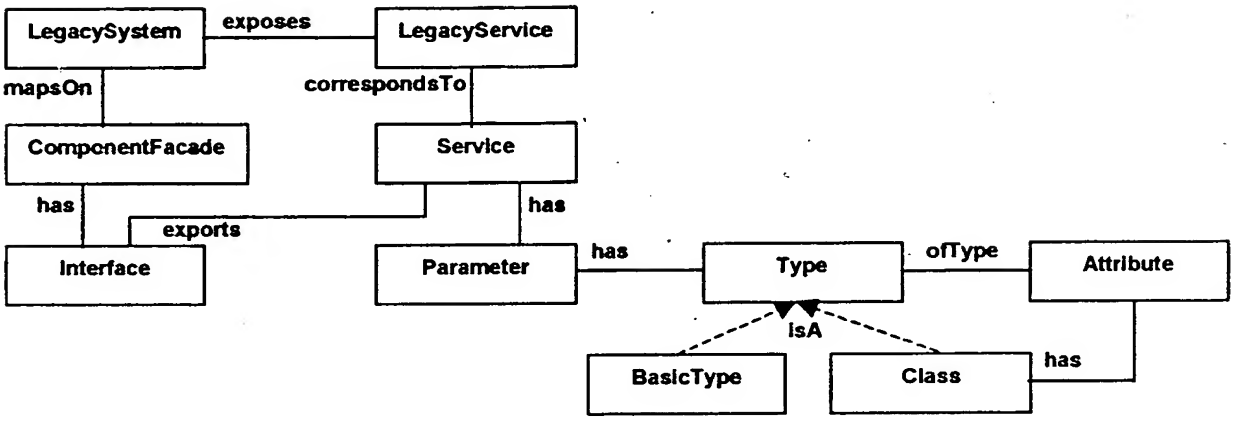

Fig 2. Model of component wrapper for legacy system

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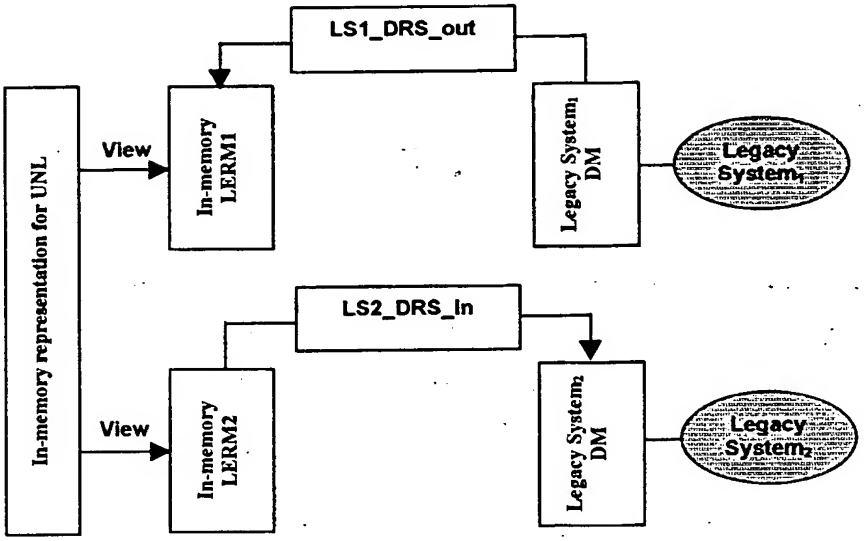

Fig. 3. Data reconciliation

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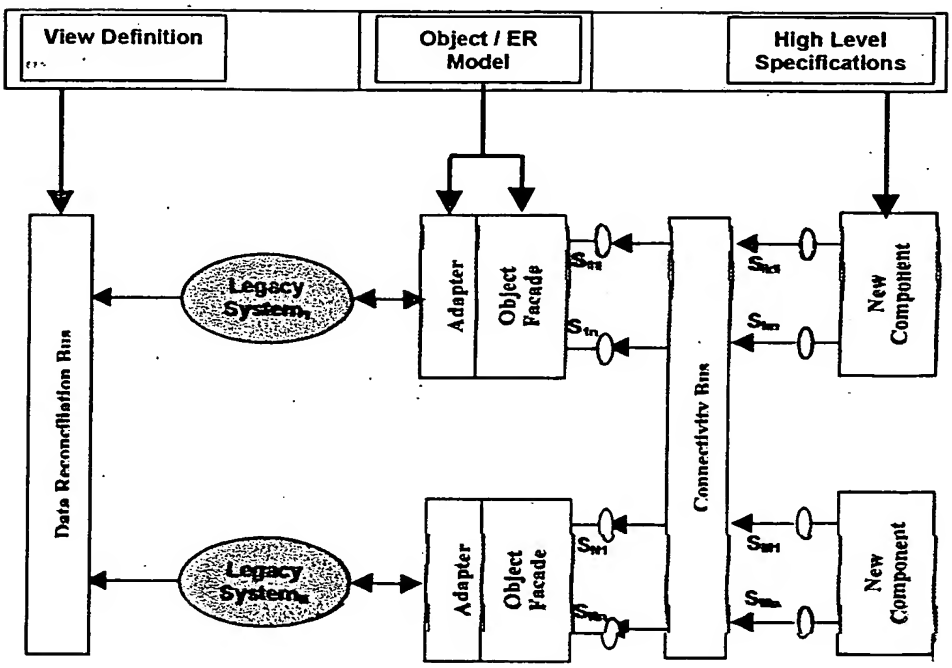

Fig 4. Tool Support

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APPLICANT'S PATENT ATTORNEY

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PROVISIONAL SPECIFICATION

```
Class Connector
{
public:
        // API to invoke a service in synchronous manner
        virtual ErrorStatus callService ( Request *svcName ) = 0;

        // API for obtaining input parameters of a service
        virtual ErrorStatus getParamsFromBuffer( DArray *in );

        // API for returning from a service
        virtual ErrorStatus returnAcrossNetwork ( Response *svcName );

        // API for obtaining return values of a service
        virtual ErrorStatus returnedFromService ( Darray *out );

        // API to invoke a service in asynchronous manner
        virtual ErrorStatus callAService ( Request *svcName, Token &token );

        // API to invoke a service in queued manner
        virtual ErrorStatus callQService ( Request *svcName, Queue *inQ );

        // API to poll a service invoked in asynchronous manner
        virtual ErrorStatus checkReply ( Token *token );

        // API to poll a queue
        virtual ErrorStatus checkStatus ( Queue *inQ, Qstatus &qs );
};
```

Figure - 5 (continued)

MOHAN DEWAN
APPLICANT'S PATENT ATTORNEY

PROVISIONAL SPECIFICATION

```
Class Request
{
private:
        char *svcName;
        TxnInfo *tinfo;          // Transaction information
        Darray *in;              // Darray of input parameters
Public:
        Char *getSvcName();
        Void setSvcName( char *name );
        TxnInfo *getTxnInfo();
        Void setTxnInfo( TxnInfo *ti );
        ErrorStatus AddParam( Object *p );
        Int sizeof();
        Void serialise( char *buf );
        Void unserialise( char *buf );
};

Class Response
{
private:
        char *svcName;
        ErrorStatus status;      // Status of invocation
        Darray *out;             // Darray of return values (in/out + out)
        Darray *errs;            // Darray of (application) error objects
Public:
        Char *getSvcName();
        Void setSvcName( char *name );
        ErrorStatus *getStatus();
        Void setStatus( ErrorStatus st );
        ErrorStatus AddParam( Object *p );
        ErrorStatus AddError( Object *e );
        Int sizeof();
        Void serialise( char *buf );
        Void unserialise( char *buf );
};
```

Figure 5

MOHAN DEWAN
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